Phytoextraction: Commercial Considerations

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Dr. Michael J. Blaylock holds a Ph.D. in soil chemistry from the University of Maryland and BS and MS degrees in agronomy from Brigham Young University. His research activities have focused on rhizosphere processes affecting trace element and heavy metal uptake by plants. Dr. Blaylock has worked for the past eight years evaluating and developing strategies to address heavy metal and radionuclide contamination of soils. Dr. Blaylock is an internationally recognized expert in the development of phytoextraction of metal-contaminated soils.

Dr. Blaylock is currently the Director of Ag Research and Development at Edenspace Systems Corporation where he leads Edenspace's research, analysis and development team. He has conducted or managed numerous phytoremediation projects at government and industrial sites including brownfields, the EPA SITE program, firing ranges within the Department of Defense, RCRA Corrective Action sites, former nuclear weapons development complexes within the Department of Energy, and a "Big Three" auto manufacturer. His research has led to five company-filed patents and more than sixteen peer-reviewed publications.

Abstract

Phytoextraction of metal-contaminated soils has emerged as an attractive alternative to traditional soil remediation methods such as excavation and disposal. The ability to use phytoextraction as a remediation tool requires plants capable of accumulating sufficient metal concentrations in their harvestable biomass coupled with biomass yield rates that facilitate a significant quantity of metal removal from the soil to achieve site goals. The successful application of this technology, however, requires an understanding of site-specific conditions and key parameters that influence performance. The site assessment process routinely includes an evaluation of soil conditions, contaminant distribution and bioavailability, remediation goals, and agronomic and phytometric analyses that allow a determination of appropriate practices (crop selection, soil amendments and conditioners, and agronomic practices) to ensure success.

To improve the performance and applicability of the technology, phytoextraction of metal-contaminated soils can be integrated with compatible ex situ and in situ technologies such as particle size separation and electrokinetic processes. Recent advances in the technology have expanded the applicability to soils with particulate contaminants, contamination below the root zone of plants, and the use of perennial crop plants and grasses. Current applications of the technology at firing ranges and RCRA Corrective Action sites will be presented and discussed to demonstrate the versatility of phytoremediation to address metal-contaminated soils.

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PHYTOREMEDIATION: Using plants to remove pollutants from the environment.

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Technologies

- **PHYTOREMEDIATION: Removal of pollutants from the environment**
- **PHYTOEXTRACTION: Metal accumulating plants to remove toxic metals from soil**
- **RHIZOFILTRATION: Hydroponic plants to remove toxic metals from polluted waters**
- **PHYTOSTABLIZATION: Contaminant-tolerant plants to reduce mobility and prevent further contamination**

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Site Challenges for Phytoextraction

- **High total metal concentrations**
- **Mixed contaminants**
- **Contaminants below the effective root zone**
- **Unfavorable water table or drainage conditions**
- **Particulate/insoluble contaminant sources**

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Phytoextraction's Place in the Remediation Tool Box

- Many sites contain inorganic contaminants that are only treated through a combination of technologies.
- The combination of phytoextraction with soil washing (particle size separation) and stabilization increases the number of sites amenable to treatment.

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Approach

- Integrate conventional remediation with innovative technologies
- Use strengths of compatible technologies to overcome site challenges

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Compatible Technologies

- Soil washing/particle size separation
- Excavation - ex situ treatment
- Electrokinetics
- Stabilization

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Phytoextraction Process

- Site investigation and assessment
- Site applicability or treatability study
- Development of agronomic practices
- Irrigation and water management
- Implementation (planting, cultivation, and harvesting)
- Monitoring and analysis
- Biomass treatment

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Treatability Study

- Soil characterization
  - Physical
  - Chemical
- Contaminant bioavailability and partitioning

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Case Study: Simsbury CT

- Surface soil lead
- Groundwater concerns
- Address leachable lead as well as total lead concentrations
- On-going site use and activities

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Summary of Results - Simsbury

- Areas exceeding total lead concentration goals were reduced.
- Average lead concentrations from all crops of Brassica juncea exceeded 1000 mg/kg.
- SPLP leachable lead decreased from an average of 0.85 in April 1998 to 0.08 mg/L in October 1999.

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Case Study - DaimlerChrysler

- Three-acre ex situ site remediation
- Elevated lead concentrations below the root zone
- One year clean-up target

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DaimlerChrysler Approach

- **Excavate subsurface soils for ex situ placement**
- **Two crops (Brassica juncea, sunflower)**
- **Dispose of soil exceeding total lead regulatory goal at the conclusion of one season**

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Commercial Success

- **September 21, 1999 - DaimlerChrysler presented a 1999 Environmental Excellence award to the Detroit Forge Phytoremediation Project Team**
- **Attended by more than 150 DaimlerChrysler environmental professionals from throughout the world, the annual meeting recognized seven top environmental projects**
- **The award recognized that the team's innovative use of phytoremediation saved DaimlerChrysler more than $1,000,000 compared to alternative remediation techniques**